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Title, Test Section, The Infantry Board

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REPORT

of

The Infantry Board

No. 1547

FRAGMENTATION GRENADE: TEST OF EFFECTIVENESS

FORT BENNING, GEORGIA

18 December 1943

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SUBJECT: Fragmentation Grenade: Tests of Effectiveness.

TO: Chief of Ground Requirements Section, Army Ground Forces, Army War College, Washington, D. C.

1. Authority and Purpose. a. Tests of the effectiveness and suitability of five types of fragmentation grenades based upon the present standard Grenade, Hand, Fragmentation, Mark II, as shown in detail in the inclosed Report of Test, were conducted in accordance with oral instructions from Requirements Section, Army Ground Forces, and in general, with a previous directive for test of the British Hand Grenade No. 36, as given in 1st Indorsement, Ground Requirements Section, Army Ground Forces, dated 4 October 1943, GNRQT 11/55441, (Appendix "A") and are directly related to tests previously reported, of the British hand Grenade No. 36. (Report of The Infantry Board No. 1531.)

b. The tests were designed to determine the probable casualty-producing effectiveness and general suitability for combat use as a hand-grenade of the standard Mark II fragmentation grenade with Fuze M10A3 in comparison with the four proposed modifications of the same grenade having various types of explosive fillers, and all fitted with the T-1 fuze (4.5 sec.; non-sparking; detonator).

2. Description of Material. Five types of grenades were tested, referred to herein as "Group I" to "Group V", as follows:

"Group I." - Standard body of Grenade, Fragmentation, Hand, Mark II, with non-sparking time train and ignition head, (M10A3) and loaded with 0.74 oz. of EC Blank powder (standard loading) as bursting charge.

"Group II." - Standard body of Grenade, Fragmentation, Hand, Mark II, with non-sparking time train and detonator (T-1 Detonating Fuze) and with same bursting charge as Group I.

"Group III." - Same as "Group II", but loaded with 1.00 oz. of E.C. Blank Powder as exploding charge.

"Group IV." - Same as "Group II", but loaded with 1.5 oz. of flake T.N.T. as bursting charge.

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"Group V." - Same as "Group II", but loaded with 2.0 oz. of flake T.N.T. as bursting charge.

3. Factual Background. a. Facts developed by The Infantry Board incident to tests of Grenade Projection Adapter M1 and Grenade, Rifle, Fragmentation M17, indicated a disappointing casualty-producing effectiveness in the standard Grenade, Hand, Fragmentation, Mark II, which carries a bursting charge of E.C. Blank Powder with a simple ignition fuze. Experiments conducted by the Board in that connection indicated that this grenade's effectiveness would be greatly increased by the substitution of a bursting charge of high explosive, with a suitable detonator, for the E.C. powder charge and ignition fuze. (See Report of The Infantry Board No. 1456.) Ground Forces accordingly recommended:

(1) Immediate modification of the Mark II hand grenade by providing it with a filler of high-explosive; and

(2) A long-range development of a new design of grenade body to improve uniformity and size of fragmentation.

b. Information from the early fighting in the Southwest Pacific area disclosed general dissatisfaction with the Mark II hand grenade, and a general preference for the British grenade used by Australian troops in that area. Complaints from the troops related more specifically to the fact that the fuze of the Mark II Grenade emitted a train of sparks visible at night which tended to disclose the position of the grenadier and to warn enemy personnel to take evasive and counter measures. The corresponding munition of the Japanese as well as the British Grenade No. 36 did not have this weakness. Their effectiveness both from the standpoint of casualty production and morale effect was also greater because of the greater power of the bursting charge. The adaptation, for U.S. forces, of the hand grenade for use as a front-line mortar through projection to greater distances by means of the rifle grenade launcher has greatly increased the importance of such grenade. Four of the grenades here reported upon represent various attempts by the Ordnance Department to comply with recommendation "(1)", above, and, apparently, to eliminate objectionable sparking of the fuze-train previously encountered in Fuze, M10A2.

c. The present standard Grenade, Hand, Fragmentation, Mark II, is essentially the same as the "defensive" hand grenade of 1917-1918 except as to the bursting charge. The World War defensive grenade had a high-explosive filler with a suitable detonator. The change to the filler of E. C. Blank Powder and igniting match was made at the end of that war, and is understood to have been based upon the following apparently conflicting considerations:

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(1) The power of the detonation of the high explosive charge was dangerous to the user unless he was under cover.

(2) The violence of the detonation of the high-explosive charge produced pulverization, rather than effective fragmentation, of the body and therefore reduced casualty-producing effect except within a small radius.

d. At the present time the basic fragmentation hand grenade is employed in combat in the following ways:

(1) As a hand grenade, at ranges up to a maximum of thirty-five (35) or forty (40) yards.

(2) As a rifle-grenade, time-fuzed, with Projection Adapter, M1, to ranges up to about one hundred and eighty (180) yards. (280 or more yards when using auxiliary propelling charge.)

(3) As a rifle-grenade with impact fuze (Grenade, Rifle, Fragmentation, M17) for ranges up to about two-hundred and twenty (220) yards. (320 yards or more when using auxiliary propelling charge.)

(4) As a "booby-trap" or anti-personnel mine (with a pull-type ignition device and trip-wire, etc.)

e. The Infantry Board has recently recommended that, pending improvement in our own hand grenade, the British hand grenade No. 36 be made available to our troops in the active theaters. (Report of The Infantry Board No. 1531), because of its superior effectiveness and its non-sparking fuze-train.

4. Results of Tests: The present tests indicated:

a. That neither the Fuze, M10A3, nor the Fuze T-1, produces any train of sparks while burning which is objectionable for night use, but the T-1 fuze emits a certain amount of smoke perceptible in daylight. (Tests Nos. 6 and 7.)

b. That the unmodified Grenade, Hand, Fragmentation, Mark II, is only about 33% effective as a casualty agent at a radius of 2-1/2 yards. (Test No. 2; Appendix "C"; Plate I.), and practically ineffective beyond such radius.

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c. That when the Grenade, Hand, Fragmentation, Mark II, is modified by the inclusion of a detonator in the fuze assembly in lieu of the igniter (Group II; Fuze T-1) its fragmentation is multiplied approximately seven times (Test No. 1), its average casualty producing effect at corresponding distance about six times, and its probable effective casualty radius is increased to between 2-1/2 and 5 yards. (Test No. 2; Appendix "C"; Plate I.)

d. That when the Mark II Grenade body is furnished with the T-1 fuze and detonator, and the bursting charge is increased to one ounce of E.C. Blank powder, (Group III) its effective fragmentation at corresponding distances from the point of detonation is multiplied by about six over that secured with the standard charge of E.C. Powder with detonator, (Group II) and by approximately forty over the present standard Mark II grenade (Group I); and makes it fully 100% effective at a radius of five yards and about 60% effective at a radius of 10 yards. (Test No. 2; Appendix "C"; Plate II.)

e. That the Mark II Grenade body when fitted with the T-1 fuze and loaded with 1-1/2 oz. of flake T.N.T. (Group IV) is approximately equal in fragmentation to that with the T-1 fuze and one (1) ounce of E. C. Blank powder (Group III) (Test No. 2; Plates II and III); the casualty-effect of such fragments is increased by approximately fifty per cent (50%) over the E.C. Blank powder grenade (Group III), and its probable effectiveness is increased to about ninety per cent (90%) at a 10-yard radius.

f. That the Mark II Grenade, fitted with a T-1 fuze and loaded with two (2) ounces of flake T.N.T. (Group V) is fifty per cent (50%) more effective at close range than any other grenade tested, and has a probable casualty effectiveness of approximately 100% at a 10-yard radius. (Test No. 2; Appendix "C".)

g. That the all-around casualty-effectiveness of the Mark II Grenade fitted with a T-1 fuze and loaded with two (2) ounces of T.N.T., is superior to that of any other type of grenade tested. (Tests Nos. 3, 4, 5) but the grenade is somewhat more dangerous to the thrower at 15 yards or less. (Test No. 8.)

h. That the effectiveness of the Grenade, Fragmentation, Rifle, M17, is greatly increased by substitution of a loading of two (2) ounces of T.N.T. for the present E.C. Blank powder filler and the addition of a detonator to the present standard impact fuze.

i. That all of subject grenades are slightly risky to the person throwing them, at twenty-five yards or less, when the grenadier is erect and in the open; grenades of Groups III, IV and V (loadings, 1 oz. E.C. Powder,

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1-1/2 oz. of T.N.T., and 2 oz. T.N.T.) are moderately dangerous to the grenadier at 20 yards or less under the same conditions; at 25 yards and beyond the danger to the grenadier when erect and in the open is negligible, and at 15 yards or over the danger from any of these grenades is negligible if he assumes a prone position. (Test No. 8.)

5. Discussion. The nature of some phases of the present war, involving, as it does, frequent mopping-up operations against a fanatical and extremely tenacious enemy, especially in densely wooded and rugged terrain, together with the current method of projecting hand grenades from the rifle and carbine far beyond the ranges formerly involved, has made a revision of our conception of desirable characteristics in hand grenades necessary. The deadliest possible effectiveness of single grenades against enemy personnel consistent with reasonable safety to the using personnel is called for, and this personal safety consideration applies only when the grenade is thrown by hand. It disappears when it is projected by other means to greater distances. While some proportion of hand grenades will probably continue to be thrown by hand, and it is therefore necessary to consider a balance between effectiveness against the enemy and danger to the grenadier, it should be borne in mind that the advantages, both in range and opportunities for employment in combat, will tend to increase the importance of their projection from the rifle and carbine by small units employing mortar technique: when so used the controlling consideration is effectiveness. In view of this it seems that for the relatively small proportion of special occasions when projection by hand is resorted to, it is both feasible and desirable to accept and allow for a certain amount of hazard to the grenadier, and to train troops so to use it as to insure reasonable safety to themselves while inflicting the greatest possible damage upon the enemy.

The distance to which a hand grenade can be thrown by the average individual may be taken as thirty-five to forty yards. When exploded at those distances the danger to the thrower is found by this test to be negligible in comparison with other risks of battle. The distance beyond which danger to the thrower becomes practically negligible is indicated in the present tests to be between 20 and 25 yards, even when the thrower is in the erect position and in the open. If he throws from cover or from a crouched or prone position, as he should, the risk is practically non-existent beyond 15 yards. It seems, therefore, that if the grenadier is trained to take a proper position when using a hand grenade against a target substantially less than twenty-five yards away, then any one of the subject grenades can be so used without difficulty. The fact that the British forces in this war use a hand grenade whose power is at least equal to the most powerful of the subject grenades, and that such of our own troops who have had occasion to use it like it, indicate that this is true in fact as well as in theory.

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It seems clear that the present Mark II grenade is very nearly useless, except for morale effect, and that this condition extends to the present M17 rifle grenade which is an adaptation of the Mark II. Both can be greatly increased in effectiveness by the mere addition of a No. 8 detonator to the fuze, and this is a change that can be made in the field. It is probably the only change feasible in the case of the millions of grenades already in the hands of troops or in the supply "pipe-lines". It should therefore be considered from the standpoint of a field expedient to be put in effect at the earliest possible date by the issue of the necessary replacement fuzes but by no means as a permanent solution.

This change still leaves the grenade far short of the minimum effectiveness believed to be imperatively needed, and that effectiveness can only be achieved by changing the explosive charge to a more powerful type. Of the various fillers tested, the two-ounce loading of flake T.N.T. appears to give a very satisfactory fragmentation pattern at a radius of 10 yards without involving undue danger to a user familiar with its characteristics and reasonably well trained. Since that filler also gives the greatest effectiveness when the grenade is projected from a rifle so as to obtain air bursts or used as a component of the M17 rifle grenade, there seems to be no adequate reason for not adopting it.

6. Conclusions. The Infantry Board concludes:

a. That the present standard Grenade, Hand, Fragmentation, Mark II, and the present standard Grenade, Rifle, Fragmentation, M17, have inadequate fragmentation and casualty-producing effect, and are unsatisfactory.

b. That both of the above grenades can be greatly increased in effectiveness although not to the full extent believed necessary by the addition of a detonator to the standard fuze, and that this change is feasible in the field if the proper type of fuzes and detonators are furnished together with appropriate instructions and materials for their installation.

c. That satisfactory effectiveness without undue danger to the user, can be secured with the present body of the Mark II hand grenade, by loading it with two ounces of flake T.N.T. and fitting it with a sparkless, detonator-type fuze, such as the Fuze, T-1.

d. That Fuze, T-1, is satisfactory and desirable as a substitute for all present types of fuzes for fragmentation hand grenades.

7. Recommendations: The Infantry Board recommends:

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a. That all Grenades, Fragmentation, Hand, Mark II, now in the hands of troops be modified without delay by substitution of the T-1 fuze assembly for the present fuzes.

b. That all Grenades, Fragmentation, Hand, of future production, and all now in storage to which the change can be applied, be loaded with two ounces (2 oz.) of T.N.T. or other equivalent charge of high explosive, and fitted with Fuze T-1 or equivalent fuze; and that the production of the present standard Mark II grenade be discontinued.

c. That immediate consideration be given to field modification of Grenades, Fragmentation, Rifle, M17, by adding a No. 8 detonator to the impact fuze assembly affixed to the present fuze.

d. That future production of Grenades, Fragmentation, Rifle, M17, be filled with a two-ounce (2 oz.) charge of flake T.N.T., or an equivalent charge of other high explosive, and the present impact fuze be modified by the addition of a No. 8 detonator fixed in place on the fuze.

e. That the M10A1, M10A2 and M10A3 fuzes for the Mark II fragmentation hand grenade be declared non-standard and their production, issue and use discontinued other than for training.

For the President:

INGOMAR M. OSETH,
Colonel, Infantry,
Director.

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REPORT of TEST

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COMPARATIVE FRAGMENTATION OF MARK II GRENADES WITH VARIOUS LOADINGS AND FUZES

TEST SECTION
THE INFANTRY BOARD
FORT BENNING, GEORGIA

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Submitted to
THE INFANTRY BOARD

Copy No. 6 Date 25 Nov 1943.

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TEST SECTION
THE INFANTRY BOARD
FORT BENNING, GEORGIA

25 NOVEMBER 1943

SUBJECT: Report of Test of Comparative Fragmentation of Mark II Grenades with various Loadings and Fuses.

TO: The President, The Infantry Board, Fort Benning, Georgia.

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I AUTHORITY AND REFERENCES

1. Authority:

a. Letter, The Infantry Board, Sept. 24, 1943, (IB-400.112) with 2 Indorsements. (Appendix "A".)

b. Letter, The Infantry Board, October 6, 1943, (IB 471.6). (Appendix "B".)

2. Introductory Information:

a. The fuze assembly and body of subject grenades has the same outward appearance as the standard Mk II type. The body being serrated cast iron and the fuze being the bouchon type. Dimensions of subject grenade are the same as the standard Mk II and there is no noticeable difference in weight.

b. The subject grenades received for test were loaded and fuzed as follows: (Throughout this test the grenade types will be referred to by group as indicated.)

(1) 50 Grenades, C.I., loaded with .74 oz. EC Blank Powder and assembled with M10A3 Igniting Fuze. (Group I)

(2) 50 Grenades, C.I., loaded with .74 oz. EC Blank Powder and assembled with T1 Detonating Fuze. (Group II)

(3) 50 Grenades, C.I., loaded with 1.00 oz. EC Blank Powder and assembled with T1 Detonating Fuze. (Group III)

(4) 50 Grenades, C.I., loaded with 1.50 oz. Flake TNT and assembled with T1 Detonating Fuze. (Group IV)

(5) 50 Grenades, C.I., loaded with 2.00 oz. Flake TNT and assembled with T1 Detonating Fuze. (Group V)

II PURPOSE OF TEST

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3. To determine:

a. Fragmentation tests as follows:

(1) Static - when detonated within a panel inclosure (ground impact).

(2) Casualty effect of each group of subject grenade when hand thrown and when projected from a rifle. (Ground impact.)

(3) Casualty producing effect of air bursts against personnel in foxholes.

(4) Complete fragmentation in sand.

b. The distance at which the smoke trail left by the burning fuse can be seen in daylight.

c. Whether these grenades can be seen as they are thrown or projected at night.

d. If the impact detonator from the M17 Grenade will fire the charges in the TNT loaded grenades.

e. The danger of subject grenades to using personnel.

III DETAILS OF TEST

4. Test No. 1.

Ammunition lot PAE - 61174-1828 - Special Test.
Weapon - Grenade C.I.

a. Purpose of test:

To determine the relative total fragmentation of each group of subject grenade.

b. Method:

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A box 6' x 6' was constructed and lined with bags of sifted sand. The bags were placed so as to allow the grenade to explode in an open space giving normal fragmentation. Three of each group of grenades were fired and fragments sifted from the sand in a standard 1/16" mesh screen.

c. Results:

(1) Group I - M1043 Fuze. -.74 oz. EC.

(a) Average number of fragments, 63.
(b) Size range of fragments, 2" x 2" to 1/8" x 1/8".
(c) Average size of fragments, 1" x 1/2". (See Plate I.)

(2) Group II - T1 Fuze - .74 oz. EC.

(a) Average fragments from grenades fired 439.
(b) Size range of fragments 1" x 1/2" to dust.
(c) Average size of fragments, 1/4" x 1/4".

(3) Group III - T1 Fuze - 1.00 oz. EC.

(a) Average fragments from grenades fired, 772.
(b) Size range of fragments, 3/4" x 1/4" to dust.
(c) Average size of fragments 3/16" x 3/16".

(4) Group IV - T1 Fuze - 1.5 oz. TNT.

(a) Average fragments from grenades fired, 715.
(b) Size range of fragments 3/4" x 1/4" to dust.
(c) Average size of fragments 3/16" x 3/16".

(5) Group V - T1 Fuze - 2.00 oz. TNT.

(a) Average fragments from grenades fired, 1,307.
(b) Size range of fragments 1/2" x 1/4" to dust.
(c) Average size of fragments 1/8" x 1/8".

5. Test No. 2.

a. Purpose of Test.

(1) To determine the distribution and penetration of the fragments of each group of subject grenade when fired statically on the ground.

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b. Method:

(1) An enclosure of panels 6' high was constructed of 1" pine boards. The enclosure was made in 3 sections, each section to cover a 120° arc. The sections were placed at ranges of 2-1/2 yards, 5 yards and 10 yards from a central point.

(2) Twenty grenades of each group were fired in the inclosure. Five were fired vertically and five were fired with the fuse pointed at each panel intersection so as to give overall distribution of fragments.

(3) Scoring was accomplished by counting the total numbers of hits on each panel and the number of perforations through the 1" boards.

c. Results:

Group	I	II	III	IV	V
Type	Mk II	Mk II	Mk II	Mk II	Mk II
Filler	.74 oz. E.C.	.74 oz. E.C.	1 oz. E.C.	1-1/2 oz. Flake TNT	2 oz. Flake TNT
Fuze	M10A3	T1	T1	T1	T1
Fuse Time (sec.)	4.5	4.5	4.5	4.5	4.5
Grenades Fired	20	20	20	20	20
Average number of hits 2-1/2 yard circle	41.7	357	846.3	970.5	1491.9
Average number of perforations 2-1/2 yard circle	9.6	32.7	59.3	72.0	116.0
Average number of hits 5 yard circle	23.4	154.5	968.7	1106.7	1270.7
Average number perforations 5 yard circle	8.0	21.9	39.2	44.1	76.8
Average number of hits 10 yard circle	17.0	51.2	308.7	456.6	481.7
Average number perforations 10 yard circle	5.1	11.9	15.9	15.3	23.9

6. Test No. 3.

a. Purpose of Test.

To determine the relative casualty effect of each group of subject grenades when thrown by hand. (Ground impact.)

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b. Method:

An area 36 yards square was cleared and 3 dimensional targets were placed in the area in the following manner. Kneeling silhouettes were placed on 5 yard center. Prone boxes 10" x 18" x 72" were placed on 5 yard centers to represent prone riflemen.

Five grenades of each group were thrown into the panel area. Hits secured on the panels and boxes were counted.

c. Results:

	Average targets hit per grenade fired
Group I	6
Group II	11
Group III	22
Group IV	14
Group V	16

7. Test No. 4.

Weapon - M1903 Rifle.
M1903 M1 Grenade Launcher.
M1 Grenade projection adapter and blank cartridge, M3.

a. Purpose of Test:

To determine the relative casualty effect of each group of subject grenades when projected by a grenade launcher. (Ground impact.)

b. Method:

An area 36 yards square was cleared and 3 dimensional targets were placed in the area in the following manner. Kneeling silhouettes were placed on 5 yard center. Prone boxes 10" x 18" x 72" were placed on 5 yard centers to represent prone riflemen.

Five grenades of each group were projected into the panel area from a rifle mounted on a fixed rest. Hits secured on the panels and boxes were counted.

c. Results:

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	Average targets hit per grenade fired
Group I	4
Group II	9
Group III	22
Group IV	12
Group V	23

8. Test No. 5.

a. Purpose of Test:

To determine the casualty effect of each group of subject grenades when burst in the air over entrenched troops.

b. Method:

An area 36 yards square was cleared and 3 dimensional targets were placed in the area in the following manner. Kneeling silhouettes were placed on 5 yard center. Prone boxes 10" x 18" x 72" were placed on 5 yard centers to represent prone riflemen. Standard foxholes 20" deep were dug on a 5 yard center. A cardboard panel was placed in the bottom of each hole. Five grenades of each group were fired at an elevation of 8 feet. The grenades were suspended from a pole by wire for firing. They were allowed to swing freely after the pin was pulled to give a normal dispersion and varied angles of fall.

c. Results:

	Average number panels in foxholes hit per grenade	Average number silhouettes and boxes hit per grenade
Group I	1	9
Group II	1	14
Group III	1.6	12.4
Group IV	1.4	27.5
Group V	1.8	37.2

9. Test No. 6.

Time 1130 - 1 November 1943.
Weather - Clear.
Weapon - Mk II Grenade - T1 Fuze.

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a. Purpose of Test.

(1) To determine if the subject grenades disclose the point of origin of the grenade in daylight due to smoke emitted from the fuse.

b. Method:

Observers were placed at 50 yard intervals up to 800 yards on a line extending from the gun position perpendicular to the line of flight of the grenade. Five grenades were projected from the rifle so as to give an air burst.

c. Results:

All observers up to 700 yards could plainly see the smoke trail left by the burning fuse during the entire flight of the grenade. The smoke trail was not visible over 700 yards at all times and faded immediately when observed beyond this distance.

10. Test No. 7.

Time 2000 - 15 November 1943.
Weather - Clear.
Weapon - Mk II Grenade - T1 fuze and M10A3.

a. Purpose of Test:

To determine if the subject grenades disclose their point of origin at night when projected from a rifle due to sparks emitted from the fuse.

b. Method:

Observers were so placed as to be able to observe the origin, flight, and impacts of the grenades. Seven grenades were fired separately from the rifle so as to give an air burst.

c. Results:

There was no trace of sparking of the fuse in any of the grenades. In two cases a streak of fire followed the grenade a few yards when it left the muzzle of the gun. It is believed that this flash was caused by burning of oil in the gun barrel and had no connection with fuse.

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11. Test No. 8.

Weapon - Grenades of all five groups.

a. Purpose of Test:

To determine the relative danger of the subject grenades to the using personnel.

b. Method:

(1) The results of Test No. 2 were analyzed to determine the danger to using troops up to 10 yards.

(2) For ranges up to 40 yards a panel 6' high and 20' long was constructed and placed at the end of an area having no obstructions larger than weeds 2' high. Three each prone and kneeling silhouettes were placed in front of the panel. Grenades were placed on the ground at 5 yard intervals and fired statically. Four grenades of each group were fired at each range.

c. Results:

(1) No hits were made on the prone targets.

(2) Five hits were made on the three kneeling silhouettes and these were made at 15 yards by group V grenades.

(3) The following is the average number of hits on the 6' x 20' panel per grenade fired:

	15 yards	20 yards	25 yards	30 yards	35 yards	40 yards
Group I	1	1	1	0	0	0
Group II	1	2	0	0	1	0
Group III	5	3	1	0	1	0
Group IV	3	6	1	1	0	1
Group V	9	3	1	1	1	1

(4) Grenades fired in weeds at 20 yards and over, did not register hits on panels. It was only after blasts cleared away the weeds on the ground that the fragments went out at low angles.

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12. Test No. 9.

Ammunition - M17 Grenade - Flake TNT - No. 8.

Blasting Caps - Group V grenades.

a. Purpose:

(1) To determine the detonating quality of the M17 fuze on a TNT filled grenade.

(2) To determine the effect of incorporating a No. 8 blasting cap in the fuze of the M17 grenade, when used with a TNT filled grenade.

b. Method:

(1) Five grenades of Group V were refuzed with the impact fuze of the M17 grenade and fired into the silhouette and prone target area.

(2) Five grenades of Group V were refuzed with the impact fuze of the M17 grenade with the addition of a No. 8 blasting cap slipped into the fuze port of the tail assembly. The grenades were fired into the silhouette and prone target area.

c. Results:

	Average number targets hit per grenade
(1) M17 TNT loaded	4
M17 TNT loaded - with No. 8 Cap	14

(2) The present M17 grenade detonator gave a very poor detonation to the TNT loaded grenade. It detonated and fractured similar to the Mk II standard grenade. The addition of the No. 8 blasting cap however gave the grenade the same performance as the Group V grenades.

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IV SUMMARY OF FACTS DETERMINED BY TEST

13. The foregoing tests have disclosed the following facts:

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a. The Group I grenade has very poor fragmentation characteristics. (Ref. Par. 4. c. (1)) (Par. 5. c.)

b. The Group I grenade is relatively ineffective against personnel. (Ref. Par. 6. c., Par. 7. c., Par. 8. c.)

c. The Group I grenade fuse does not spark at night when projected or thrown. (Ref. Par. 10. c.)

d. The Group I grenade fuse leaves a smoke trail visible 700 yards on bright days. (Ref. Par. 9. c.)

e. The Group II grenade has an increased fragmentation of approximately 7 to 1 over the Group I grenade - but does not give a sufficiently dense pattern. (Ref. Par. 4. c. (2), Par. 5. c.)

f. The Group II grenade is not sufficiently effective against personnel. (Ref. Par. 6. c., Par. 7. c., Par. 8. c.)

g. The fuse of the Group II, III, IV, and V grenades does not spark at night when projected or thrown. (Ref. Par. 10. c.)

h. The fuse of the Group II, III, IV and V grenades leaves a smoke trail visible 700 yards on bright days. (Ref. Par. 9. c.)

i. The Group III grenade has good fragmentation giving a fair pattern. (Ref. Par. 4. c. (3), Par. 5. c.)

j. The Group III grenade is effective against personnel. (Ref. Par. 6. c., Par. 7. c., Par. 8, c.)

k. The Group IV grenade has equivalent fragmentation to the Group III grenade. (Ref. Par. 4. c. (4) (2), Par. 5. c.)

l. The Group IV grenade is effective against personnel. (Ref. Par. 6. c., Par. 7. c., Par. 8, c.)

m. The Group IV grenade compares in all tests equivalent to the Group III grenades. (Ref. Par. 4. c., (2), Par. 5. c., Par. 6. c., Par. 7. c.)

n. The Group V grenade has an excellent fragmentation and pattern. (Ref. Par. 4. c. (2), Par. 5. c.)

o. Indications are that the Group V grenade would be very satisfactory against personnel. (Ref. Par. 6. c., Par. 7. c., Par. 8. c.)

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p. The Group V grenade is the best of the grenades tested when used with air burst on personnel in foxholes. This use of grenades is of little value unless used on hastily prepared positions where the troops are not well below the surface of the ground, or are still on the surface. (Ref. Par. 8. c.)

q. The M17 grenade filled with TNT with the present impact detonator is similar in performance to the present M17 grenade. (Ref. Par. 12.)

r. The M17 grenade filled with TNT and the present impact detonator supplemented with a No. 8 blasting cap gave very favorable results and compared closely to the Group V grenade on the panel area. (Ref. Par. 12.)

W. S. SINCLAIR, JR.,
Captain, Infantry,
Test Officer.

I concur in the above report:

WILLIAM C. RUTHERFORD,
Lt. Col., Infantry,
Chief of Test Section.

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APPENDIX

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OFFICE OF
THE INFANTRY BOARD

IB-400.112

Fort Benning, Georgia.
24 September 1943.

Subject: Material Received.

To: Chief, Ground Requirements Section,
Army Ground Forces, Army War College,
Washington, D. C.

1. Ninety Six Grenades, Hand or .303 Rifle No. 36M MK 1 were received by The Infantry Board from Camp Ordnance Officer, Petawawa Military Camp, Ontario, Canada, on 23 September 1943.

2. No test directive has been received.

For the President:

(Signed) NED BLAIR,
Lt. Col., Infantry,
Recorder.

GNRQT-11/55441 (24 Sep 43) 1st Ind.

GROUND REQUIREMENTS SECTION, HQ., Army Ground Forces, Washington, D. C., 4 October 1943.

To: President, Infantry Board, Fort Benning, Georgia.

1. Subject grenades are to be service tested comparatively with the Mark II Hand Fragmentation Grenade to determine their relative values for combat use.

2. Particular attention to be paid to the emission of sparks when thrown at night and of smoke when thrown in daylight. Also effect of fragmentation, ease of carrying and throwing, and burning time of fuse.

3. Report of test to reach this Headquarters not later than 20 Oct. 1943.

For the Chief, Ground Requirements Section:

(Signed) GEARY F. EPPLEY,
Lt. Col., G. S. C.,
Assistant Executive,
Ground Requirements Section.

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APPENDIX "A"

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IB-471.6 2nd Ind.
(24 Sep 43)
THE INFANTRY BOARD, Fort Benning, Georgia,
8 October 1943.

To: Chief of Test Section, The Infantry Board, Fort Benning, Georgia.

1. Expedite tests will be conducted in accordance with preceding indorsement and letter, Infantry Board, dated 6 October, 1943 to Chief of Test Section, Subject: "Grenades".

2. Report of Test will be rendered The Infantry Board not later than 16 October, 1943.

3. Lt. Col. Ned Blair is the Board member charged with this project.

For the Director:

NED BLAIR,
Lt. Col., Infantry,
Recorder.

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APPENDIX "A"

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IB-471.6

6 October 1943.

Subject: Grenades.

To: Chief of Test Section,
The Infantry Board.

1. The following material has been furnished The Infantry Board for service and comparative tests:

a. 50 Grenades, C.I., loaded with .74 oz. EC Blank Powder and assembled with M10A3 Igniting Fuze.

b. 50 Grenades, C.I., loaded with .74 oz. EC Blank Powder and assembled with T1 Detonating Fuse.

c. 50 Grenades, C.I., loaded with 1.00 oz. EC Blank Powder and assembled with T1 Detonating Fuse.

d. 50 Grenades, C.I., loaded with 1.50 oz. Flake TNT and assembled with T1 Detonating Fuse.

e. 50 Grenades, C.I., loaded with 2.00 oz. Flake TNT and assembled with T1 Detonating Fuse.

2. It is desired that fragmentation tests be conducted to determine the comparative effectiveness of the above types of grenades:

a. Static - when detonated within a panel inclosure (ground impact).

b. In normal angle of fall when thrown by hand and fired from the Grenade Projection Adapter (ground impact).

c. Casualty producing effect of air bursts against personnel in fox holes.

3. In conjunction with the above tests, expedite comparative tests will be conducted of the Australian Grenade, Hand or Rifle .303, No. 36 M MKI, to include:

a. Methods of projection from the rifle.

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APPENDIX "B"

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b. Visibility in both daylight (smoke) and darkness (sparks).

4. a. Results of tests of the Australian No. 36 M MKI Grenade will be submitted separately at the earliest practicable date.

b. Upon completion of all tests Report of Test will be rendered The Infantry Board.

5. Lt. Col. Ned Blair is the Board member charged with this project.

For the Director:

NED BLAIR,
Lt. Col., Infantry,
Recorder.

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APPENDIX "C" To Report of The Infantry Board No. 1547.

Analysis and Interpretation of results of Formal Fragmentation Tests of Modified Fragmentation Grenade Mark II, as tabulated in Test No. 2.

1. Test No. 2 tabulates the average number of hits secured with each of the five types of hand grenades tested on continuous screens six feet in height placed in a complete circle with radii of 2-1/2 yards, 5 yards and 10 yards, respectively, with the point of detonation as the center, and the number of these hits having sufficient force to perforate a board of Georgia pine approximately one inch thick, composing such screen. This method is in accordance with what is understood to be the standard procedure of the Ordnance Department in such tests, and furnishes a picture of the relative fragmentation effect of two or more items tested. Complete perforation of the one-inch board is assumed to indicate sufficient lethal effect to represent disabling wounds.

2. In analyzing the tabulation above referred to, it seemed apparent that:

a. The figures showing the total number of hits and total perforations on the entire screen indicates only the relative fragmentation effect as between two or more grenades under comparison, but does not furnish a clear indication of the absolute casualty-radius of any one grenade.

b. In order to evaluate any grenade as to its absolute adequacy in casualty-producing effect, the number and nature of hits produced by it per unit-area at various ranges should be determined.

c. While total penetration of a one-inch board may be a satisfactory index of the power to produce immediate disablement or death, men in the open without cover other than average clothing will probably be sufficiently injured to require evacuation for treatment if struck by fragments having half such penetrating power or better.

3. In order to compute the probable casualty-producing adequacy of each type of grenade involved in Test No. 2 in the light of the above, the following assumptions based on the law of probabilities were made:

a. That a man's body in the open, considered as a target, and considering the various positions he may assume, will, on the average, present a cross-sectional area of at least one-half square yard.

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b. That, of the total number of fragments registered on a one-inch panel as ranging from mere indentations to complete perforations, one-half have penetrated to a depth of one-half inch or more.

c. That fragments penetrating to one-half inch or more in a hard pine board can be considered as producing probable casualties.

4. Based upon the above, and upon the tabulation given in Test No. 2, the following table shows the expectancy of "Immediate disabling" (perforations) and "probable casualty-producing" hits per person for each type of grenade at the distances indicated:

Expected Hits Per Person

Type of Grenade	"Group I"	"Group II"	"Group III"	"Group IV"	"Group V"
2-1/2 yards Radius					
"Immediately disabling"	0.15	0.50	0.90	1.12	1.8
"Probable casualties"	0.33	2.84	6.75	7.70	11.9
5 yards Radius					
"Immediately disabling"	0.06	0.16	0.30	0.35	0.6
"Probable casualties"	0.09	0.60	3.80	4.40	5.0
10-yard Radius					
"Immediately disabling"	0.02	0.05	0.06	0.06	0.10
"Probable casualties"	0.03	0.10	0.60	0.90	1.00

Note: Summarizing and Generalizing from above:

Group I Grenades are 33-1/3% effective at 2-1/2 yards, 10% effective at five yards, and only 3% effective at 10 yards.

Group II Grenades are 140% effective at 2-1/2 yards, 60% effective at 5 yards and 10% effective at 10 yards.

Group III Grenades are 330% effective at 2-1/2 yards, 380% effective at 5 yards and 60% effective at 10 yards.

Group IV Grenades are 750% effective at 2-1/2 yards, 430% effective at 5 yards and 90% effective at 10 yards.

Group V Grenades are 1150% effective at 2-1/2 yards, 500% effective at 5 yards, and 100% effective at 10 yards.

APPENDIX "C"

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Type Grenade	Percent Effectiveness at Radius of 2-1/2 Yards	5 Yards	10 Yards
I	33%	9%	3%
II	284%	60%	10%
III	675%	380%	60%
IV	770%	440%	90%
V	1190%	500%	100%

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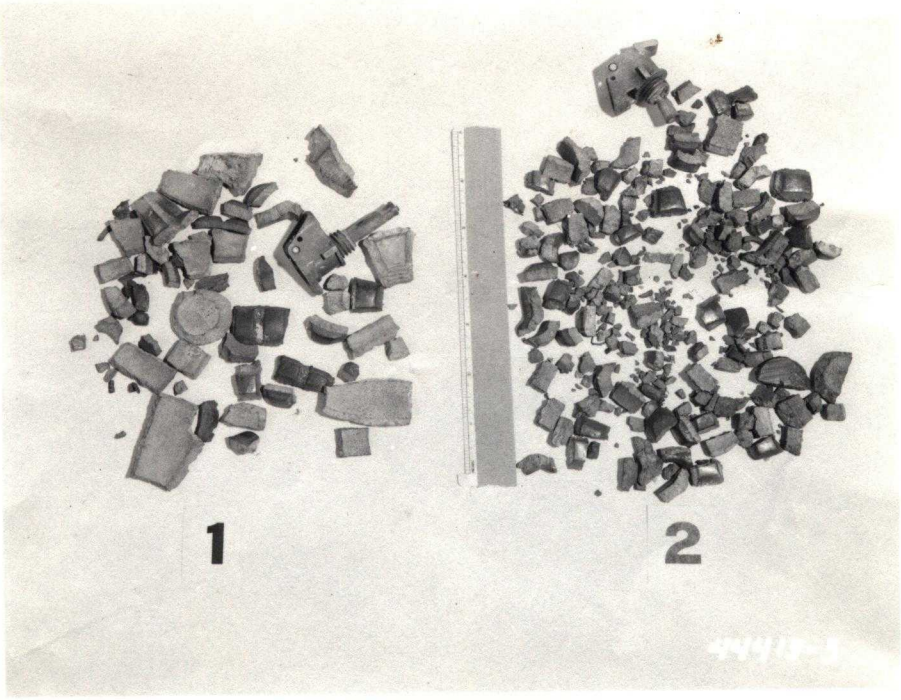

Scale 1/3+

GRENADES

GROUP I

Type: MK II
Filler: .74 .oz. EC
Fuze: M10A3 - Igniting

GROUP II

Type: MK II
Filler: .74 .oz EC
Fuze: T1 Detonating

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PLATE I

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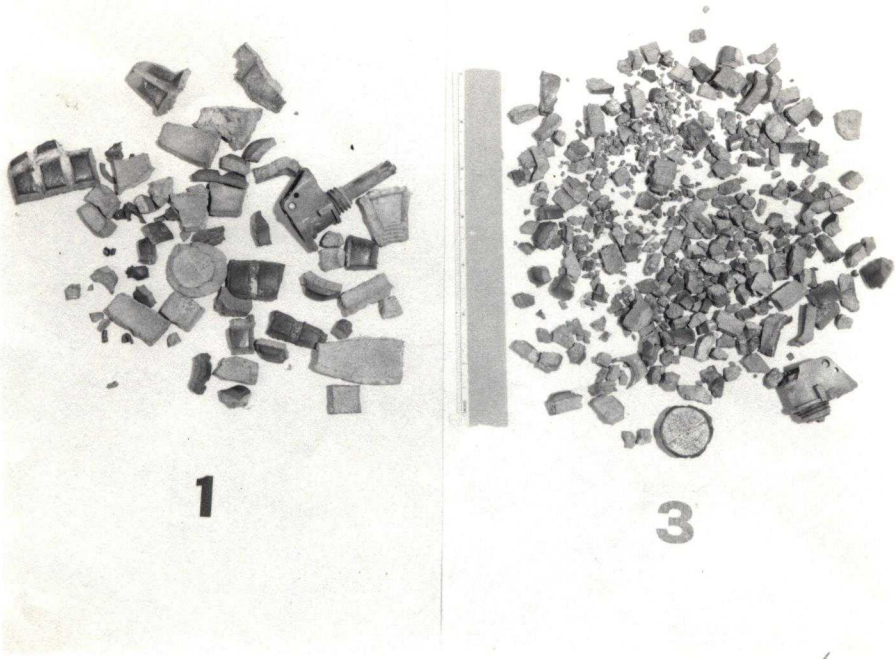

GRENADES

Scale 1/3+

GROUP I

Type: MK II
Filler: .74 .oz. EC
Fuze: M10A3

GROUP III

Type: MK 11
Filler: 1.00 oz EC
Fuze: T1

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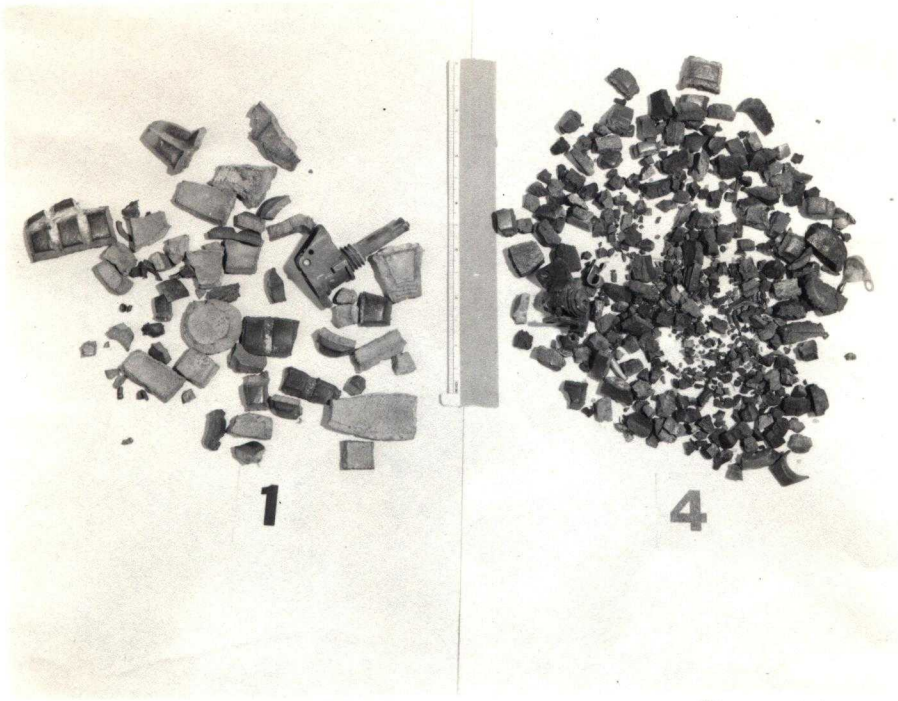

Scale 1/3+

GRENADES

GROUP I

Type: MK ii
Filer: .74 .oz EC
Fuze: M10A3

GROUP IV

Type: MK 11
Filer: 1.5 oz TNT
Fuze: T1

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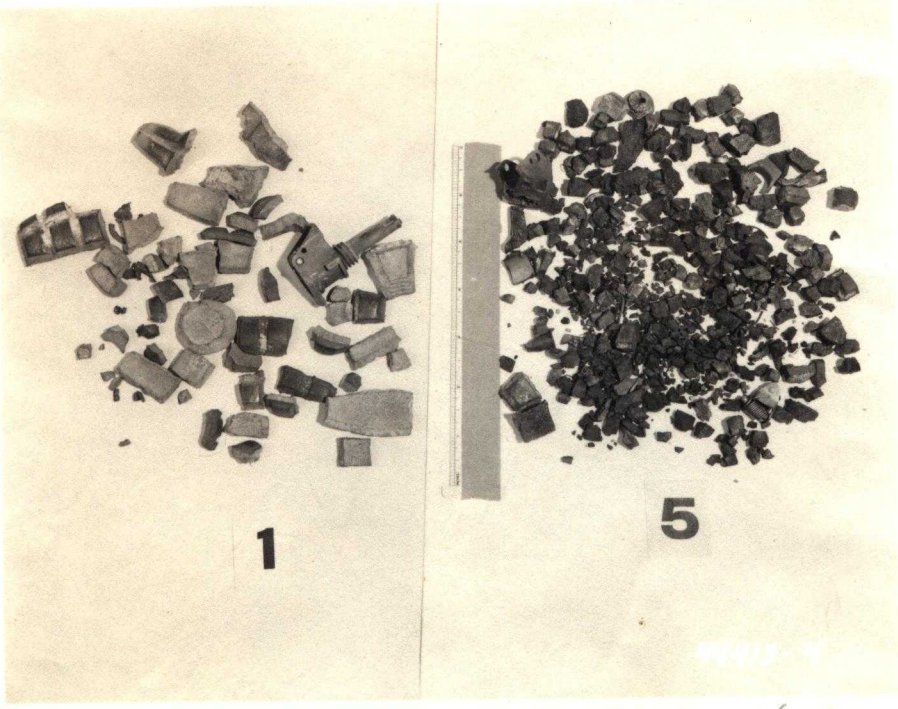

Scale, 1/3+

GRENADES

GROUP I

Type: MK 11
Filler: .74 oz EC
Fuze: M10A3

GROUP V

Type MK 11
Filler: 2.00 oz TNT
Fuze: T1

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